

REVISION OF THE *NYSTALEA AEQUIPARS* WALKER
SPECIES COMPLEX WITH NOTES ON NYSTALEINE
GENITALIA (LEPIDOPTERA: NOTODONTIDAE)

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Abstract.—The genus *Proelymiotis* Schaus is placed in synonymy with *Nystalea* Guenée. The *N. aequipars* species complex is defined, and contains four species. Two new species, *N. corniculans* and *N. montana* are described. Diagnoses and illustrations are provided for all species in the *aequipars* complex. A brief description of nystaleine genitalic and prothoracic leg structures is also provided.

The genus *Nystalea* Guenée (1852) (Lepidoptera: Noctuoidea: Notodontidae) is comprised of medium to large-sized moths, and contains forty-two species (Weller, unpubl.). Representatives of this genus are found as far north as Florida (*N. indiana* Grote) and southern Texas (*N. collaris* [Schaus]) and as far south as Argentina (*N. nyseus* [Cramer]). Larvae have been reared on from the following plant families: Myrtaceae, Anacardiaceae, Sapindaceae and Guttiferae (Todd, 1973; specimen label data), but preserved larval material and descriptions are lacking. Almost nothing is known about the adult biology.

My systematic work on the higher classification of the tribe Nystaleini reveals that the type species of the genus *Proelymiotis* Schaus, *P. aequipars* Walker, shares derived genitalic characters with the genus *Nystalea*, and lacks derived features that would support recognition as a separate genus. Therefore, I place *Proelymiotis* as a synonym of *Nystalea*. I describe the general, genitalic characteristics of the Nystaleini (Forbes, 1935, 1948; Weller, 1989), and the derived genitalic characters of *Nystalea* to justify this synonymy. The *N. aequipars* species complex is diagnosed, two new species belonging to this complex are described, and male and female genitalia of *N. aequipars* and related species are illustrated.

METHODS

I removed abdomens from museum specimens and placed them in hot 10% KOH (potash). These were then cleaned in several rinses of 40% ethanol. I stained preparations with either chlorozol black (Kodak or ICN) dissolved in 20% ethanol, or with chlorozol black followed by saffranin dissolved in 95% ethanol. Stained preparations were positioned, dehydrated, and mounted in either euparal (BMNH specimens) or balsam (all other specimens). Antennae, palps and legs were treated similarly except they were not stained before mounting. Wings were bleached and then stained overnight with eosin Y before mounting. Terminology follows Forbes (1948), Sibatani et al. (1954), and Klots (1970). I define new terminology below.

Label data is given exactly as it appears on specimens. Comments, dissection numbers and collections are included in brackets. Abbreviations for type repositories

and collections consulted are: AMNH, American Museum of Natural History; BMNH, British Museum (Natural History); CAS, California Academy of Sciences; CMNH, Carnegie Museum of Natural History; CNC, Canadian National Collections of insects, arachnids and nematodes; CRNM, Costa Rican Museum of Natural History; LACM, Los Angeles County Museum, California; DJ, D. Janzen, private collection, Pennsylvania; NMNH, National Museum of Natural History; SJW, S. J. Weller, private collection, Texas; VOB, V. O. Becker, private collection, Brasilia, Brazil; ZMHB, Zoologisches Museum an der Humboldt-Universität zu Berlin.

GENITALIC AND PROTHORACIC LEG MORPHOLOGY OF
NYSTALEA AND RELATED GENERA

Male prothoracic leg

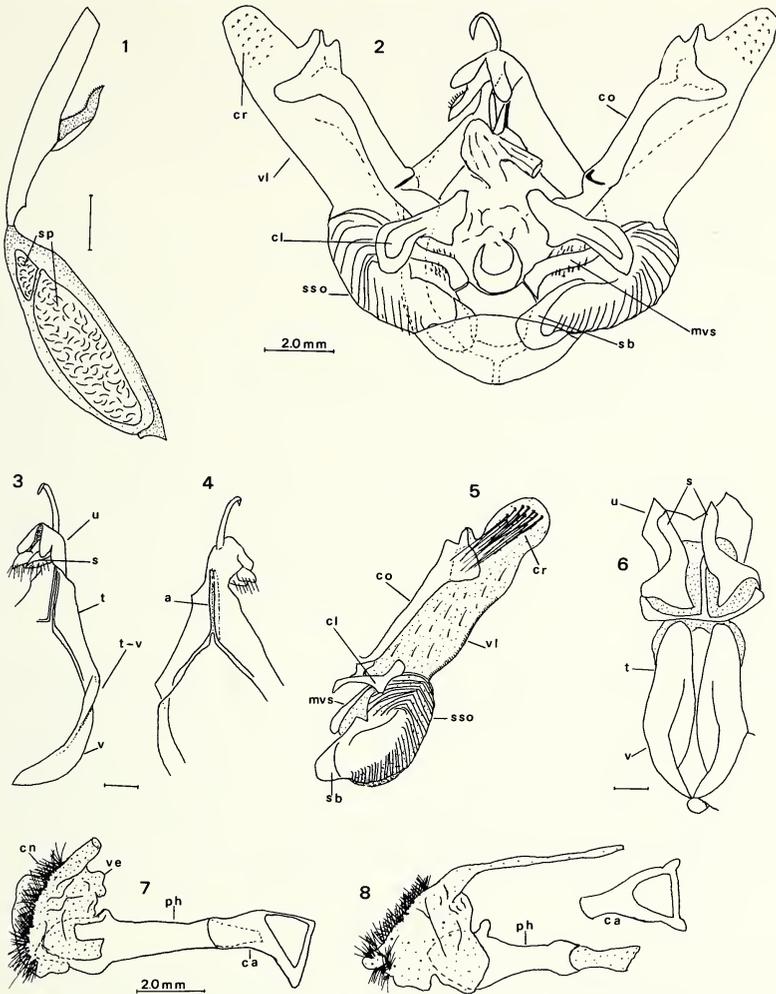
In many nystaleines, the males possess a prothoracic femur and tibia that are modified for pheromone production and dissemination. The lateral, anterior surface of the femur has one (*Calledema* Butler, *Bardaxima* Walker) or two (*Nystalea*) elliptical areas of thin, slightly invaginated membrane covered with wooly hairs and surrounded by flat, square-tipped scales with widely spaced lamellae (Fig. 1). Longer hairs overlay this area, and a cluster of long, stiff hairs occurs on the prothoracic tibia. This structure is analogous to the male mesothoracic leg pheromone emitting organ in the Noctuidae. Presumably, the femoral membranous areas produce short-range pheromones that are distributed by the tibial scent pencil during male courtship. I refer to these prothoracic leg structures as *scent pockets*.

Genitalia

Little descriptive morphology of notodontid genitalia is available in the literature (Forbes, 1948; Barth, 1955; Holloway, 1983). New terminology is defined here for structures in *Nystalea* and related genera. This information is extracted from a larger study of neotropical notodontids (Weller, unpubl.).

Male genitalia. *Tegumen, vinculum and sociuncus* (Sibatani, 1972) (Figs. 2–4, 6). The region of the vinculum homologous to the noctuid saccus, is nearly fused and a sclerotized, caudal extension covers the base of the sacculus. The tegumen-vinculum connection in many neotropical notodontids is fused in an S-shaped configuration (Figs. 3, 4) that differs from the C-shaped fusion found in the European genus *Pheosia* Huebner (Fig. 6). The uncus base is fused to the tegumen in *Nystalea*, and a pair of apodemes or sclerotized thickenings extend from the tegumen into the uncal base (Figs. 3, 4). These apodemes are present in several nystaleine genera (i.e., *Tachuda* Schaus, *Strophocerus* Moeschler), but unfused connections between the tegumen and uncus occur in other nystaleine genera (i.e., *Bardaxima*). The tegumen-uncal fusion also may be variable within a genus (i.e., *Calledema*). In *Nystalea*, the shape of the uncus is unique: the base projects ventrally in two, sclerotized lobes and a slender, curved, often membranous uncal process extends dorsally (Figs. 2–4). *Socii* are present in most notodontids. In *Nystalea*, the *socii* are sclerotized and articulating.

Valve (Figs. 2, 5). The sacculus of nystaleines is composed of a sclerotized, inner area with membranous pleats. The sclerotized area provides sites for muscle attachment and either fuses or articulates with the juxta (sacculus base; sb). Long scales similar to androconia of other moths arise from the base of the sacculus. Barth (1955)



Figs. 1–8. Scale equals 1.0 cm unless otherwise indicated. 1. Scent pocket (sp) located on male prothoracic femur of *Nystalea* sp. 2. Male genitalia of *N. aequipars* (1732 BMNH); cl = costula, co = costa, cr = corona-like structure, mvs = midvalve sclerotization, sb = sacculus sclerotized base, sso = saccular scent organ, vl = valvula. 3. Caudal view of tegumen, vinculum and sociuncus of *Nystalea virgula* (1383 BMNH), valve removed; s = socii, t = tegumen, t–v = area of tegumen–vinculum fusion, u = uncus, v = vinculum. 4. Cephalic view of same showing apodemes present at tegumen–uncus fusion. 5. Left valve of same. 6. Caudal view of tegumen, vinculum and sociuncus of *Pheosia tremula* (1287 BMNH). 7. Aedeagus of *N. aequipars* with callosum; ca = callosum, cn = cornuti, ph = phallus, ve = vesica. 8. Aedeagus of *N. similis* (SJW507 CNC) with callosum removed.

demonstrated that a gland is located within the sacculus of *Hemiceras proximata* Dognin. The hemiceratine sacculus is homologous to the nystaleine. Presumably, pheromones are produced and distributed by this modified sacculus. I will refer to this structure as the *saccular scent organ*. The size of the nystaleine saccular scent organ varies within and between genera. The dorsal edge of the sacculus is defined by a strip of sclerotization extending to the anellus and fuses with the juxta in many species. This *midvalve sclerotization* (mvs) effectively separates the saccular and costal compartments.

In *Nystalea*, the dorsal edge of the costa (co) consists of a sclerotized rod that extends two-thirds the length of the valve and widens into a characteristic shape. Beyond this widening, the distal portion is membranous with short setae and stiff hairs arranged like a noctuid corona (Forbes, 1954). The notodontid and noctuid structures are not necessarily homologous, and I will refer to the notodontid structure as *corona-like* (cr). From the base of the dorsal edge of the costa, a sclerotized process extends into the anellus where muscle attachments occur. Presumably, these structures, in conjunction with the sociuncus and costa, provide traction *in copula*. Forbes (1948) suggests that these notodontid processes may be homologous with structures in the genera *Himera* Duponchel and *Nacophora* Hulst (Geometridae) and with the hairy pads of the family Thyatiridae. From limited observations, the processes in these three families do not appear to be homologous. I will refer to the notodontid structure as the *costula* (cl) (Latin: little rib) rather than "costal process" to distinguish it from the costal process of the sacculus (Forbes, 1954). Costular shape is usually species-specific.

Between the sclerotized, costal rod and the midvalve sclerotization, a membranous area exists with scattered setae or with defined patches of setae and hairs. This consistently well-defined area in nystaleine genitalia appears to be homologous with the "valvula" of Pierce (1914). Pierce (1914) originally applied the term to the central, lightly sclerotized area between the sclerotized costa and sacculus of a geometrid valve. Sibatani et al. (1954) restrict the term to the "ventro-apical region" of the valve, however, consistent and homologous application of an apical-basal division of the male valve seems unlikely. I follow Pierce (1914) in applying the term valvula (vl) to the midarea between the sclerotized costa and sacculus as defined by the midvalve sclerotization.

Anellar region. The anal tube is usually weakly sclerotized ventrally. Ventral to the costula, scattered setae occur in the region of the manica, and the juxta is sclerotized and slightly to extremely concave in most nystaleines.

Aedeagus (Figs. 7, 8). The vesica (=endophallus, Klots, 1970) tends to be bulbous terminating in a narrow tube that is directed cephalad rather than caudad. Deciduous cornuti are present in many notodontid genera (Forbes, 1948; Holloway, 1983), and these may vary in size or shape. The base of the aedeagus in *Nystalea* and related genera is surrounded by a separate, tube-like sclerotization that has large muscles attached to it dorsally and ventrally. The tube-like sclerotization is fused to the manica and detaches from the phallus proper at this point of fusion. I will use the term *callosus* (Latin: hard skin) to refer to this extra sclerotization encircling the base of the aedeagus. The presence of a callosus (ca) is a derived condition and defines a large group of genera corresponding in part to the Nystaleini of Forbes (1948) (Weller, 1989).

Male eighth sclerites (Fig. 9). The shape of the male eighth sternite is often species-specific in the Notodontidae (Forbes, 1948; Holloway, 1983). In *Nystalea*, the eighth tergite has a characteristic pattern of sclerotization with a midplate defined by a less melanized area that extends to the cephalic edge. Muscles attach to the edge of the sclerotized midplate which can be seen in partially digested preparations.

Female genitalia. Ovipositer and eighth sclerites (Figs. 9–11). The papillae anales of *Nystalea* and related genera are usually covered with short, scattered setae with longer, inwardly curved setae arising from the base. The papillae anales may be membranous, lightly sclerotized or extremely sclerotized depending on the species. The posterior apophyses are usually long and slender. The shape of the eighth tergite and sternite may vary within as well as between genera. Some species in *Nystalea* possess lateral processes on their sternal margins (i.e., *N. ebalea*, and *N. aequipars* species complex), others possess lateral processes on the lamellae antevaginalis (i.e., *N. marmorea* Schaus), and others possess both (i.e., *N. corrusca* Schaus). In *Nystalea* and some other nystaleines, the ostium bursae is very wide, extending nearly the entire width of the eighth sternite.

Other structures (Fig. 10). In the Nystaleini, the ductus bursae may be membranous, partially or completely sclerotized. In *Nystalea*, females have a sclerotized ductus bursae which, in some, is also dorso-ventrally flattened (e.g., *N. aequipars* and *N. virgula* Felder). In these species, the flattened edges of the ductus bursae are membranous which allows the ductus bursa to expand into a rounded tube when a hypodermic needle is inserted. The ductus seminalis arises from the left, caudal area of the corpus bursae near the ductus bursae. The corpus bursae may or may not be partially sclerotized. Single or multiple signa are present and their shape may be species-specific. The dorso-ventrally flattened ductus bursae occurs in several nystaleine genera.

Notodontid female genitalia tend to have greater morphological variety within genera than is usually found in the Noctuoidea (Franclemont, pers. comm.). It is not uncommon for female genitalia to exhibit species-specific characters in neotropical notodontids. Closely related species (i.e., *N. aequipars* species complex), however, have nearly identical female genitalia.

Nystalea Guenée

Nystalea Guenée, 1852:122 (Type species: *Nystalea conchyfera* Guenée, 1852:122, plate 9, fig. 2 [a junior subjective synonym of *Phalaena Noctua ebalea* Cramer, 1780:310, fig. C], by subsequent designation Kirby, 1892:618, see *Taxonomic note*).

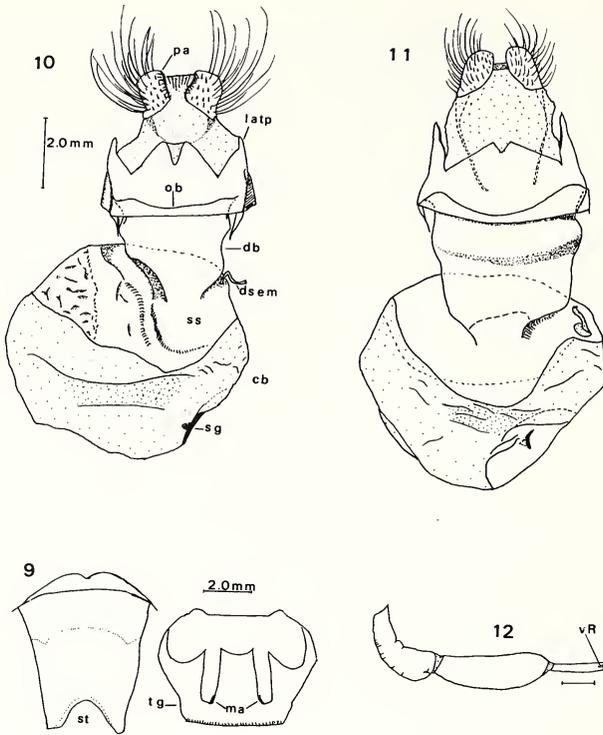
Cyrrhesta Walker, 1857:633 (Type species: *Phalaena Noctua nyseus* Cramer, 1775:119, pl. 75, fig. E, by monotypy, see *Taxonomic note*).

Eunystalea Grote, 1895:7 (Type species: *Nystalea indiana* Grote, 1884:7, by original designation).

Congruia Dyar, 1908:45 (Type species: *Congruia congrua* Dyar, 1908:45, by original designation).

Proelymiotis Schaus, 1901:273 (Type species: *Nystalea aequipars* Walker, 1858:1742, by original designation). **New Synonym** (see *Synonymical Note*).

Diagnosis. The well-developed corona-like structure of the costa and paddle-like uncus of male genitalia are derived character states of this genus.



Figs. 9–12. Scale equals 1.0 cm unless otherwise indicated. 9. Male eighth sternite and tergite of *N. aequipars*, ma = muscle attachment points, st = sternite, tg = tergite. 10. Female genitalia of *N. aequipars*; cb = corpus bursae, db = ductus bursae, dsem = ductus seminalis, latp = lateral prominences on eighth sternite, ob = ostium bursae, pa = papillae anales, sg = signum, ss = sclerotized shield. 11. Female genitalia of *N. corniculans* (SJW632 CMNH). 12. Male labial palp of *N. aequipars*; vR = vom Rath's organ.

Description. Head: antennae short bipectinate or ciliate in males, short ciliate or with scattered short setae in females; antennal scape with long tuft of scales; labial palp as in Figure 12; maxillary palp two-segmented and proboscis well-developed in both sexes. Thorax: male prothoracic femur with scent pocket; prothoracic tibia with compact brush of scales; fifth tarsomere with 4 or more long setae emanating from distal edge; metathoracic leg with long hairs in males. Abdomen: males lacking abdominal scent organs. Forewings: male from 4.1 cm (*Nystalea* undescribed sp., Cuba) to 7.0 cm (*N. lineiplena* Walker, *N. corrusca*). Male genitalia—slender, paddle-like uncus with base divided and sclerotized; socii sclerotized and projecting from underneath base; costa sclerotized for three-quarters of its length, distal fourth membranous and forming a corona-like structure; costula present; sacculus scent organ present; juxta shape characteristic (Fig. 2), abutting aedeagus but not fused to it; aedeagus with callosum; vesica with deciduous cornuti, except *N. ebalea* with spines. Female genitalia: eighth sternite usually with a pair of lateral projections; ductus

bursae sclerotized and sometimes dorso-ventrally flattened; corpus bursae sometimes sclerotized where ductus bursae joins and surrounding area, one or two signa present; ductus seminalis from dorsal, caudal area of corpus bursae.

Taxonomic note. In the *Uitlandsche Kapellen* (or *Papillons exot.*) by Cramer and Stoll, some species are not described with a genus, rather “Phal. Noct.” is given after the specific name. Subsequent workers assumed that “Phal.” was an abbreviation for “Phalaena” and “Noct.” for “Noctua,” and to be consistent with the Code, omitted one of the two generic names from the original combination. I report the original combination here because the omission is not standardized in the older literature. For example, references to both *Noctua ebalea* and *Phalaena ebalea* are found.

Synonymical note. Schaus (1901) defined the genus *Proelymiotis* based on forewing venation. Forbes (1939) questioned the validity of *Proelymiotis* as a distinct genus from *Nystalea*. Forewing venation varies within the genus *Nystalea* as defined by the male genitalic characters (Weller, 1989). *Proelymiotis aequipars* shares the derived genitalic characters of *Nystalea*, and lacks any derived features that would support its recognition as a separate genus. Thus, I place *Proelymiotis* as a junior subjective synonym of *Nystalea*.

N. aequipars species complex

Diagnosis. All species of complex neotropical with contrasting forewing coloration of basal two-thirds of forewing dark and outer third light (Figs. 20, 21).

Description. Head: male and female antennae ciliate. Thorax: dorsum various shades of cinnamon brown; ventrum grey or cream-colored. Abdomen: small tuft of scales on second abdominal tergite; dorsal surface light to dark cinnamon brown; ventral surface pale cream, sometimes with dark brown, longitudinal stripe on the midline. Forewing coloration: basal two-thirds light or dark brown; outer half either: greyish white with grey and brown mottling, pale ochre with brown or black mottling, or pale ochre with greenish hue; between the subterminal and adterminal lines, a series of dark, triangular spots. Hindwing: basal one-fourth to three-fourths white or yellow, outer part dark brown or fuscous; fringe white with brown, brown with white or pale ochre with brown markings; dorsum of veins dark brown or white. Venation as in Figure 13.

Remarks. Contrasting forewing coloration also occurs in the old world species of *Chadisra* Walker, but the male and female genitalia are completely different from *Nystalea*. The figure in Draudt (1932) labelled “*aequipars*” (pl. 144, g3) is the ochre forewing morph and the one labelled “*similis*” (pl. 144, g4) is the white forewing morph. Both are present in *N. aequipars* and *N. montana*, n. sp., and only the white forewing morph occurs in *N. corniculans*, n. sp. and *N. similis*. Hindwing color variation is discussed for each species below.

Nystalea aequipars Walker

Nystalea aequipars Walker, 1858:1742. Holotype male. Brazil.

Nystalea divisa Moeschler, 1882:44, plate 18, fig. 32. Holotype female. Surinam.

Heterocampa seminivea Walker, 1869:17. Holotype female. [Colombia] Limas.

Diagnosis. Males possess a paddle-like costula (Fig. 14).

Description. Forewing: male 4.7 to 6.0 cm ($N = 15$; $\bar{x} = 5.3$), female 5.0 to 6.7 cm ($N = 8$; $\bar{x} = 5.9$); both white and ochre forewing morph occur in this species. Hindwing: males with basal third to half white, outer part fuscous; females with basal fourth to third white, outer part fuscous; all three types of fringe coloration occurs. Male genitalia: Figure 22, gen. prep. 1736 (BMNH); the paddle-like uncus may be long and curved to extremely shortened as in a Mexican specimen (NMNH 43,167). The paddle-like costula is occasionally rounder distally with a definite "neck" (Fig. 15). Female genitalia: Figures 10, 28, gen. prep. 43,507 (NMNH).

Remarks. Schaus (1901) placed *N. divisa* and *H. seminivea* as synonyms of *P. aequipars*. The holotypes of *P. aequipars*, *H. seminivea* and *N. divisa* are the white forewing morph. Both *H. seminivea* and *N. divisa* are females. I have not dissected *P. aequipars* or *H. seminivea*, but I have examined the genitalic preparation *N. divisa*. Female genitalia are not obviously species-specific in this complex with the exception of *N. corniculans*, n. sp. Both type specimens occur within the range of *N. aequipars*, and the Schaus (1901) synonymy is not changed.

The costula variation may be an occasional developmental aberration. It appears in two specimens from Corcovado, Costa Rica and two specimens from Muzo, Columbia. These moths have darker hindwings with yellow scales compared to other specimens from the same locality with the paddle-like process. There is one specimen from Santa Rosa, Costa Rica that has one normal and one rounded costula, but it is has a normal, white hindwing. Without reared material, it is not possible to know whether the dark hind wing, rounded costula specimens represent population variation within *N. aequipars* or represent a distinct species.

Biology. A crude drawing of a caterpillar showing a modified anal segment was found under a specimen at the BMNH with the host given as *Clusia* sp. (Guttiferae).

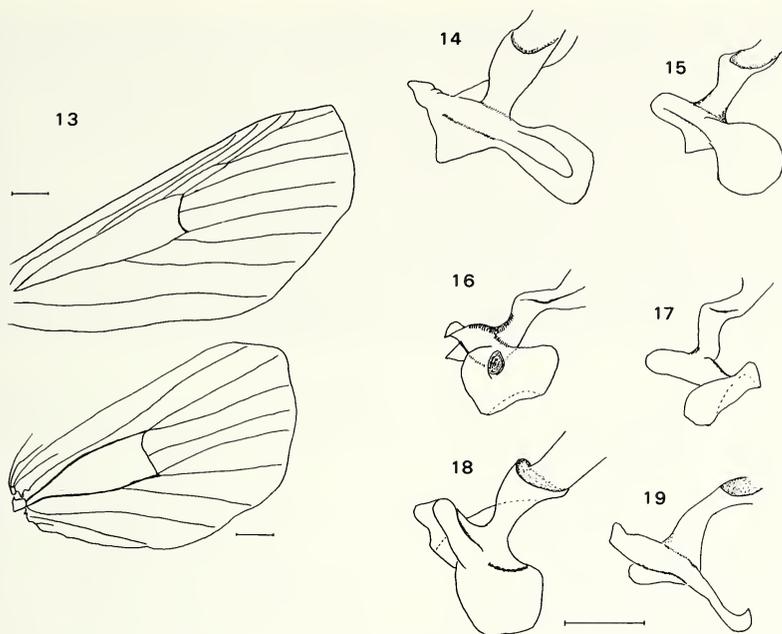
Distribution and geographic association. Geographic distribution: Mexico to Brazil, and the Antilles. Altitudinal distribution: 0–1,100 meters.

Type material examined. *Nystalea aequipars* Walker. Holotype male. Verbatim label data: "Amaz[on]," "554," "797," "TYPE: Lep No 1832, *Nystalea aequipars* Walker, HOPE DEPT. OXFORD." Condition: good.

Nystalea divisa Moeschler. Holotype female. Slide label data: "Surinam, Genitalia Prep. no. BE26 P. Thiaucourt 13IV 1981, ZMHB." Condition: genitalic preparation in good condition, did not view specimen.

Heterocampa seminivea Walker, 1869. Holotype female. Verbatim label data: "73-78, Limas," "Limas," "Heterocampa seminivea." Condition: good, with left hind wing torn.

Other specimens examined. 72 males, 33 females (dissections: 12 males, 4 females). *White hindwing.* MEXICO: 1♂—Jalapa [43,167 NMNH]; 1♀—Jalapa [NMNH]; 1♂—Orizaba, NMNH; 2♀—Cordoba, May 14'06 [43,507 NMNH]; Guatemala: 1♂—Clujel, Aug. [Dognin coll NMNH]; COSTA RICA: 1♂—Limon Prov., N edge Tort. Nat. Pk., Cerro Tortuguero, 0–100 m, 30 May 1984 [SJW496 DJJ]; 2♂—Limon Prov., 9.4 km W Bribri Suretka, 9–11 June 1983 [DJJ]; 1♀—Puntarenas Prov., 6 km S San Vito 08°42'N, 83°00'W, 13–18 March 1967 [NMNH]; 2♂—Puntarenas Prov., 35 km S Palmar Norte, Fila Esquinas, 150 m, 8°45'N × 83°20'W, 7–8 Jan 1983 [DJJ]; 1♂—same locality, 7–8 Jan 1986 [SJW494 DJJ]; 1♂—Guanacaste Prov., Santa Rosa Nat. Pk., 18–24 July 1981 [DJJ], 2♂—same locality, 1–31 July 1983, 300 m [SJW485 DJJ];



Figs. 13–19. Scale equals 1.0 cm unless otherwise indicated. 13. *N. aequipars*; forewing venation of male (1604 BMNH), hindwing venation of female (1603 BMNH). 14. Left costula of *N. aequipars*. 15. Aberrant left costula of *N. aequipars*. 16. Left costula of *N. montana*. 17. Alternate view, left costula of *N. montana*. 18. Left costula of *N. similis*. 19. Left costula of *N. corniculans*.

1♀—Guanacaste Prov., 4 km E Casetilla Ricon Nat. Pk., 700 m, 16 June 1983 [DJJ]; 2♂, 1♀—same locality, 22 May 1982 [DJJ]; 1♂—same locality, 11 April 1983 [DJJ]; GUADELOUPE: 1♂—Domaine Ducios, 24–28 June 1960 [SJW568 AMNH]; 1♂—Grand étang, 9 March 1975 [NMNH]; 2♀—Sofaia, 31 May 1975 [NMNH]; MARTINIQUE: 1♀—Colson, 15 July 1974 [43,510 NMNH]; 2♀—same locality, 2 May 1975 [NMNH]; DOMINICAN REPUBLIC: 1♀—La Plaine, 17 Feb 1964 [43,511 NMNH]; 1♀—2.2 mi E of Pont Case, 27 Jan 1965 [NMNH]; 1♀—same locality, 19 Feb 1965 [NMNH]; 1♀—same locality, 5 Feb 1964, [43,165 NMNH]; 1♂—same locality, 18 April 1965 [NMNH]; 1♀—same locality, April 26 1965 [NMNH]; 1♀—1.3 mi E Pont Casse, 10 May 1964 [NMNH]; 1♂—La Vega Prov., Hotel Montana, ca. 520 m, 10 km NE Jarabacoa, 28 May 1973 [43,166 NMNH]; TOBAGO: 1♂—St. George Prov., Hillsborough Dam, 21 March 1979 [NMNH]; ST. VINCENT: 1♂—Montreal, 11–13 Nov 1975 [NMNH]; PUERTO RICO: 1♂—Pico del Este, El Yunque Radar Station, 1,000 m, 5–6 Jan 1971 [NMNH]; 1♀—State Forest Maricao, 22 June 1955 [NMNH]; COLOMBIA: 1♂—Muzo, 400–800 m [1734 BMNH]; 1♂—Villaviciencio: Ost, 400 m [no date, SJW606 BMNH]; VENEZUELA: 2♀—Merida [coll Dognin, NMNH]; 2♂—Aragua, Rancho Grande, 1,100 m 15–16 March 1978 [NMNH]; 5♂—same locality, 30–31 March 1978 [NMNH]; BRITISH GUIANA: 1♂—Omari [NMNH]; FRENCH GUIANA: 1♀—St. Laurent du Maroni [NMNH]; SURINAM:

1♂—Paramaribo [NMNH]; BRAZIL: 1♂—St. Catherina, Rio Laeiss, Blumenau, Dec 1933 [1736 BMNH]; 1♀—same locality, Jan 1934 [1281, 1737 BMNH]; 1♂—St. Catherina, Hansa Humboldt, 60 m, July 1936 [1282 BMNH]; 4♂, 20—same locality [NMNH]; 1♂—St. Catherines [43, 169 NMNH]; 1♂—Para [1732 BMNH]; 1♀—Blumenau, 732 [NMNH]; 2♀—Bresil Joinville Arp. [Dognin coll, NMNH]. *Dark hindwing*. COSTA RICA: 4♂—Sirena, Corcovado Nat. Pk., Osa Penin. 23 March 1984 [SJW608 NMNH]; same locality, 1 May 1984 [SJW617 CMNH]; same locality, 1 May 1984 [SJW618 NMNH]; 1♂—same locality, 10–19 Aug 1980 [DJJ]; 4♂—same locality, 5–11 Jan 1981 [DJJ]; 1♂—same locality, 1 May 1984 [DJJ]; 2♂—same locality, 23 March 1984 [DJJ]; 1♂—COLOMBIA: Muzo, 4–800 m [no date, SJW607 BMNH].

Nystalea corniculans, new species

Figs. 11, 16, 23

Diagnosis. Male costula thin and curved (Fig. 19). Midventral processes of female's eighth sternite more triangular than in other species and lateral processes slightly longer (Fig. 11).

Description. Body coloration: as described in species-complex section above. Forewing: male 7.0–6.2 cm (N = 2), female 6.8 cm (N = 1); only white forewing morph known for this species. Hindwing: white with dark brown edge; fringe brown with white streaks. Male genitalia: similar to *N. aequipars* but costula differs, Figure 23, gen. prep. 1733A (BMNH); the length of the paddle-like uncus varies from extremely short (Bolivian specimen) to moderately long (Peruvian specimens), and the length of the costula varies similarly. Female genitalia: as described in diagnosis, Figure 11, genitalia preparation SJW632 (CMNH).

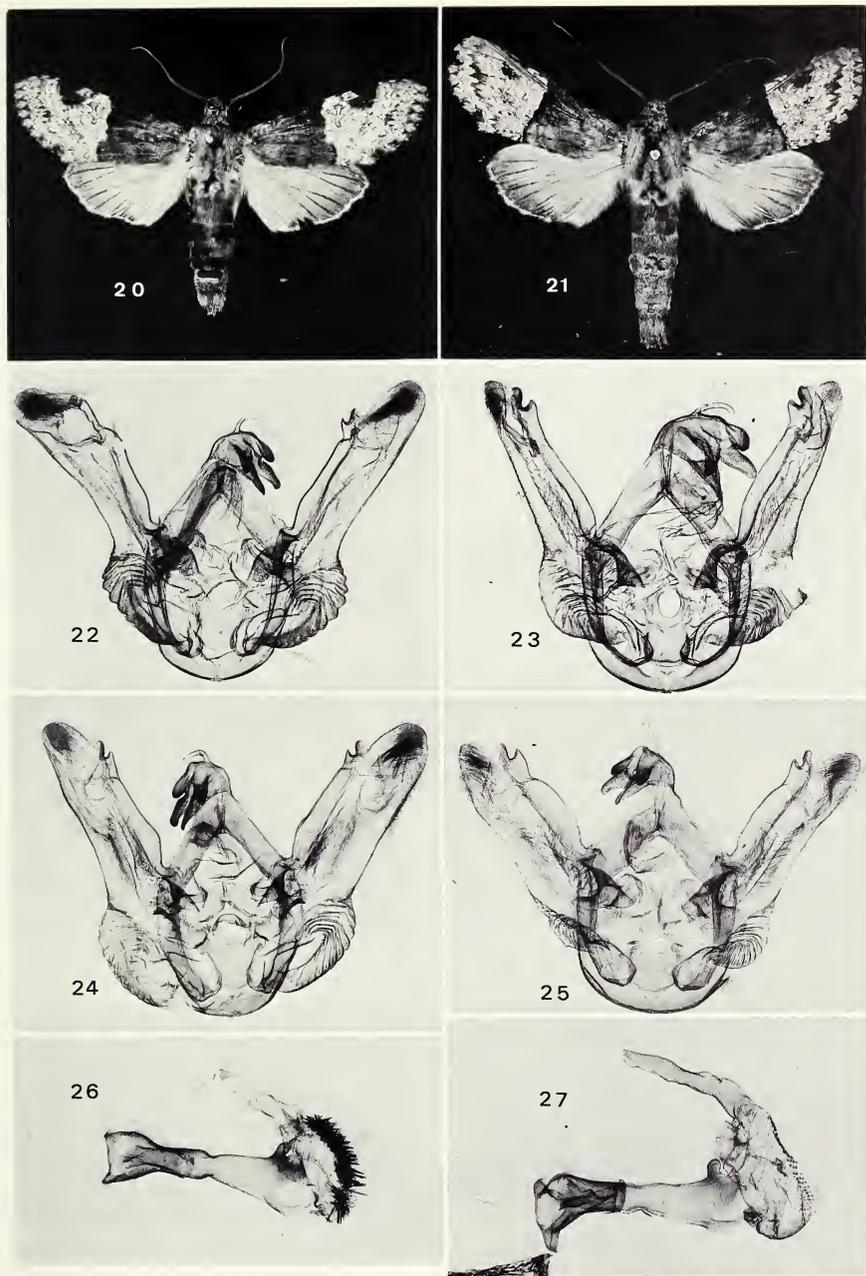
Remarks. These moths occur at unusually high altitudes for nystaleines. Unlike many high-elevation moths, the proboscis is well-developed in *N. corniculans*. Two specimens from Ecuador were collected in wet forest habitat. This species may be ecologically separated from *N. montana*, n. sp. which was collected in a semiarid habitat at 2,800 m (see below).

Distributions and associations. Geographic distribution: Ecuador, Peru, and Bolivia. Altitudinal distribution. 2,000–2,500 meters.

Etymology. The name "*corniculans*" is Latin for "*horned*" and refers to the shape of the male costal process.

Type material examined. 6 males, 1 female (dissections: 6 males, 1 female). Holotype male. Verbatim label data: "Santo Domingo, S.E. Peru, 6,000 ft., G. Ockenden," "Joicey Coll., Brit. Mus. 1922-306," "Notodontidae genitalia slide NO. 1689, a," "TYPE: *Nystalea corniculans* Weller." Condition: good.

Paratypes (5 males, 1 female). Verbatim label data: 1♀—"Ecuador: Morona-Santiago, Rio Culebrillas, 34 km SE Gualaceo, 2200m 22–23 Oct. 1987, J. Rawlins, C. Young, R. Davidson, Wet Forest [SJW632 CMNH];" 1♂—"ECUADOR: Morona-Santiago, Rio Culebrillas, 34 km SE Gualaceo, 2200m 22–23 Oct. 1987, J. Rawlins, C. Young, R. Davidson, Wet Forest [SJW630 CMNH];" 1♂—"PERU: Oconeque, Carabaya, 7,000 ft [3,500 m], July 1904, dry s. [1733a,b BMNH];" 1♂—"PERU: Dept. Amazonas, 20 km above Puente Ingenio on road to Poma cocha, Alt 1750 [m], 8 X [Oct.] 1964. F.C. Hutchison & I.K. Wright at coleman lantern [CAS];" 1♂—"BOLIVIA: Cochabamba [SJW566 CMNH];" 1♂—"BOLIVIA: vic. Santa Cruz, purchased 1966 M. Grunbaum [LACM]."



Figs. 20–27. 20. Fascies of male *N. montana*. 21. Fascies of male *N. similis*. 22. Male genitalia, *N. aequipars* (1736 BMNH). 23. Male genitalia, *N. corniculans*, paratype (1733A BMNH). 24. Male genitalia, *N. montana*, paratype (43,508 NMNH). 25. Male genitalia, *N. similis* (43,502 NMNH). 26. Aedeagus of *N. montana*. 27. Aedeagus of *N. similis*.

Nystalea montana, new species

Figs. 17, 18, 20, 24, 26, 29

Diagnosis. Male costula ends in a saucer-like disk (Figs. 16, 17).

Description (Fig. 20). Body coloration: as described in species-complex section above, but overall appearance darker than other species. Forewing: males 4.7 to 6.3 cm (N = 6, \bar{x} = 5.6), females 5.6 to 6.6 cm (N = 6, \bar{x} = 6.0); ochre forewing morph common, white morph with more grey than *N. similis*. Hindwing: with yellow (rarely white) on basal fourth, outer scales dark brown; fringe color variable. Male genitalia: differs from *N. aequipars* in shape of costula, Figure 24; gen. prep. 43,508 (NMNH), very little variation in length of uncus or other aspects of the male genitalia. Female genitalia: as in Figure 29; gen. prep. 1673 (BMNH).

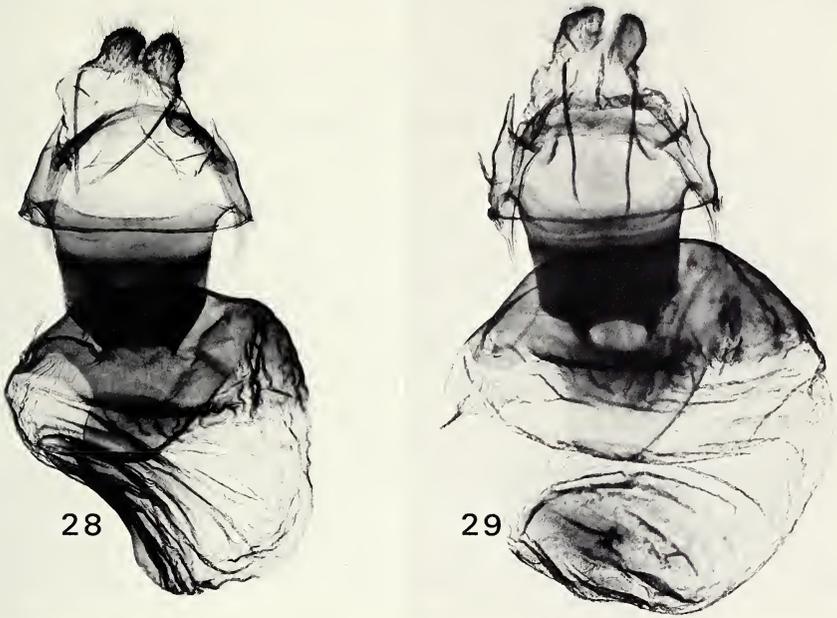
Remarks. Males collected at 730 m in Ecuador occurred in seasonal wet forest, in predominantly secondary growth with remnants of primary forest, and flew between midnight and 0330. There was one specimen collected on Chimborazo, Ecuador at 2,800 m in semiarid habitat. There are no genitalic or other obvious morphological features that separate it from the lower elevation specimens. The apparently disjunct distribution of this species probably reflects paucity of collection in crucial areas rather than a biogeographic phenomenon.

Distributions and associations. Geographical range: Costa Rica, Ecuador. Altitudinal range: 650–1,500 meters, 2,800 meters (disjunct, no specimens known between 1,500–2,800).

Etymology. The name "*montana*" was chosen because most specimens of this species were from the lower montane elevations in Costa Rica and Ecuador.

Type material examined. 51 males, 7 females (dissections: 10 males, 1 female). Holotype male. Verbatim label data: "Juan Vinas, CR," "Jan," "Rothschild Bequest B.M. 1939-I," "Notodontidae genitalia slide 1672, ♂," "TYPE: *Nystalea montana* Weller."

Paratypes (50 males, 6 females). COSTA RICA: 1♀—Juan Vinas [1673 BMNH]; 1♀—Juan Vinas, May [NMNH]; 1♂—Prov. San Jose, Estacion Carillo Pk., 700 m, July 1984 [DJ]; 1♂—same locality, Aug 1984 [DJ]; 2♂—same locality, Sept. 1984 [DJ; SJW489 NMNH]; 2♂—same locality, Oct. 1984; 1♂—same locality, Nov 1984 [43,508 NMNH]; 3♂—same locality, Feb 1985 [DJ]; 2♂—same locality, May 1985 [DJ]; 7♂—Prov. San Jose, Carillo Nat. Pk., La Montura Braulio, 1,100 m, 17 Dec 1981 [SJW486 CRNH]; 1♀—Prov. San Jose, Par. Nac. Braulio Carillo, Estacion Zurque (El Tunel), 1,500 m, Oct. 1985 [43,509 NMNH]; 2♂—Prov. San Jose, Par. Nac. Braulio Carillo, Estacion Zurqui (El Tunel), 1,500 m, 10°04'N × 84°01'W, Oct. 1985 [DJ]; 3♂, 2♀—Cartago Prov, Tapanti, Rio Grande de Orosi, 9°46'N × 83°50'W, 1,300–1,400 m, 17 Nov 1982 [DJ]; 1♂—same locality, 23 Jan 1985 [DJ]; 5♂—Cartago Prov., Moravia de Chirripo, 1,000 m, 1♀—same locality, May 1983 [SJW495 CRNH]; 1♂—Alajuela, Finca San Gabriel, 650 m, 11 Nov 1983 [SJW488 AMNH]; 5♂—Alajuela, Finca San Gabriel, 16 km ENE Queb Grande, 650 m [DJ]; 1♂—Alajuela Prov., F[in]ca la Campana, El Ensayo, 7 km NW Dos Rios, 700 m [DJ]; 1♂—same locality, 21 March 1985; 1♂—Puntarenas Prov., Monteverde, 1,400 m, 10–11 Dec 1979 [DJ]; 3♂, 1♀—Heredia Prov. El Angel Waterfall, 8.2 km downhill Vara Blanca, 1,350 m, 3 Jan 1981 [SJW487 CMNH]; 3♂—same locality, 5 Aug 1981 [DJ]; 1♂—same locality, 22 April 1984 [DJ]; 1♂—Turrialba, La Fuente, Jan 1940 [NMNH]; ECUADOR: 1♂—Dos Puentes, 700 ft, kil. 99, N.S. lot 133, Jan 1929 [NMNH]; 1♂—



Figs. 28, 29. 28. Female genitalia, *N. aequipars* (43,507 NMNH). 29. Female genitalia, *N. montana*, paratype (1673 BMNH).

Cañar, 20 km SE La Troncal, 2,200 ft [230 m], 22–28 July 1984; [SJW504 NMNH]; 1♂—same locality, 25–30 June 1984 [NMNH]; 1♂—same locality, 24 June 1984; 1♂—same locality, 16–21 July 1984 [SJW]; 1♂—same locality, 4 Aug 1984, 12–3:30 am [SJW]; 1♂—Chimborazo, 11 km NE Pallatanga, 2,800 m, 11 Nov 1987, C. Young, R. Davidson, J. Rawlins, semiarid [SJW631].

Nystalea similis Draudt

Nystalea similis Draudt, 1932:918, plate 144, fig. G. Holotype male. Brazil, Petropolis.

Diagnosis. Forewing with nearly straight border between brown and white areas and often marked by heavy black line. Male costula short and rounded (Fig. 18). Sacculus scent organ reduced one-half to one-third size of those occurring in other species. Sclerotized, ventral extension of costa is square. Distad corona-like area shorter than width of sclerotized square.

Description (Fig. 21). Forewing: male 5.1 to 5.7 cm ($N = 9$, $\bar{x} = 5.4$), female 6.1 cm ($N = 1$); only white forewing morph known for this species. Hindwing: male translucent white with little brown and white fringe; female light brown with white fringe. Male genitalia: as in diagnosis, Figures 25, 27, genitalic preparation 43,502 (NMNH); little genitalic variation observed. Female genitalia: similar to *N. montana*.

Remarks. This species is apparently restricted to southern Brazil. The range of *N.*

aequipars overlaps with *N. similis*, but the two can be separated using the presence (*N. similis*, Fig. 21) or absence (*N. aequipars*) of the straight, heavy black line, as well as the male genitalic characters.

Distributions and associations. Geographic distribution: southern Brazil. Altitudinal distribution: 450–1,300 meters.

Type material examined. Holotype male. Verbatim label data: "Petropolis, 600m, Rocha Mi[r]anda, ex. coll. W.Hopp." "gen. prep. P.Thiaucourt prep.no. BE28. 21-VI-1981 (ZMHB)."

Other material examined. 7 males, 1 female (dissections: 6 males, 1 female. Label data: BRAZIL: 1♂—Sao Paulo, Est Biol. Boraceia, nr. Salesopolis, 850 m, 14 March 1972 [SJW507 CNC]; 1♂—St. Catherina, Nova Bremen, 250 m, 7 Oct. 1926 [SJW506 CMNH]; 2♂—St. Catharina [43,502 NMNH; 1735 BMNH]; 1♂—St. Catherines, Hansa Humboldt [43,170 NMNH]; 2♂—MG, Caraca, 1,300 m, 2–4 i. [Jan] 1985 [SJW611 V.O.B.]; 1♀—Itatiaya Rio [SJW626, LACM].

ACKNOWLEDGMENTS

I thank J. Rawlins for the timely loan of the CMNH's Ecuador material. I thank the following people for their comments on the manuscript: V. O. Becker, J. Miller, R. Poole, and M. Pogue. V. Kranz kindly provided the photographs and J. Young her drafting table. This research was supported by a twelve-month Smithsonian predoctoral fellowship at the NMNH during 1986–1987.

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Received September 6, 1988; accepted March 28, 1989.

Note added in proof: One paratype of *N. montana* will be deposited in the National Museum of Ecuador (label data: Cañar, 16-21 July 1984).